Mapping Malaria and Identifying Risk Factors in Mali, West Africa

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REP applications of GIS

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Outline

- Motivation
- Objectives\Hypothesis
- Related work
- Methods
- Results
- Limitations/Further research

Motivation

- Malaria:
  - 1-2 million deaths annually (MARA)
  - 300-500 million of clinical episodes annually (MARA)
  - 90% of the deaths occur in Africa

Motivation

- GIS: an useful tool
  - Determine geographic location
  - Analyze trend over years
  - Target population at risk
  - Identify risk factors
  - Monitor intervention program

Motivation

- Creation of “Mapping Malaria Risk in Africa\Atlas du Risque de la Malaria en Afrique” (MARA/ARMA)
  - Group of malaria researchers active in Africa
  - Develop an atlas of malaria risk

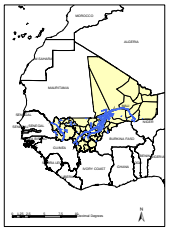
Objectives

- Identify factors that explain the variation in malaria prevalence per region
- Predict malaria in regions where data are inexistent

Hypothesis

- Malaria prevalence is affected by:
  - Climatic factors (temperature and rainfall)
  - Water bodies
  - Agricultural practices (rice, maize, and irrigation)

Mali



- Population: 12 million
- 80% labor force: agriculture and fishing
- 8 administrative regions
- 49 sub-regions

Related work

- Kleinschmidt et al. (2000, 2001a, 2001b)
  - West Africa
  - Mali
  - South Africa
- Klinkenberg et al. (2004)
  - Sri Lanka

Methods

- Overview:
  - Map mean malaria prevalence for 22 sub-regions (out of 49 sub-regions)
  - Map and disaggregate at the sub-region level factors that could explain malaria prevalence
  - Create variables
  - Modeling and predictions
  - Map the predictions

Methods

- Shape files (farming system, rivers, lakes, dams)
  - **Clip** "Farming System" layer and "Administrative Boundaries" layer
  - **Intersect** "Clip_Output" layer and "Administrative Boundaries" layer
  - Update areas of the different type of farming system (Calculate Values)

Methods

- Raster files (monthly rainfall, elevation, temperature)
  - "Administrative Boundaries" .SHP file ⇒ Coverage file
  - **Clip** "Administrative Boundaries" and the raster files (ArcInfo)
  - Spatial Analyst (Zonal Statistics)

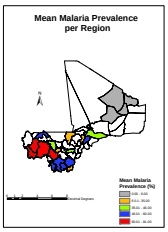
Methods

GIS Variables	Created Variables
Monthly rainfall	-Quarterly average -Number of months rainfall > 60 mm
Farming system	-Dummy variable (1 = presence) -% of different system per region
Rivers	% land as river (river/land)
Lakes	% land as lake (lake/land)
Dams	Dummy variable (1 = presence)
Elevation	Mean elevation
Temperature	Mean yearly temperature

Methods

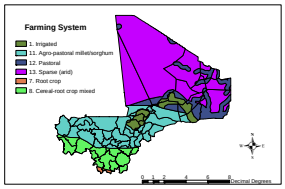
- Model
  - Probit $[\pi(x)] = \alpha + \beta x$
  - 2 variables included:
    - Nb of months rainfall > 60 mm
    - Dummy variable indicates the presence of agro-pastoral farming
- Predictions

Results

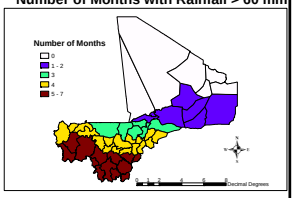


Results

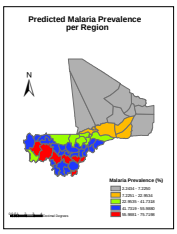
Type of Farming System

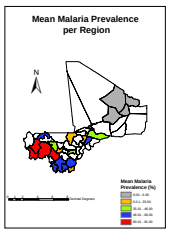


Number of Months with Rainfall > 60 mm



Results





Results

Region	Observed Values	Predicted Values	Variation
ABEIBARA	0.00	2.24	-2.24
TESSALIT	0.17	2.24	-2.07
BOUREM	1.53	4.98	-3.45
KIDAL	3.05	2.24	0.81
DIRE	5.60	22.95	-17.35
KADIOLO	33.47	69.50	-36.03
KOULIKORO	34.20	49.14	-14.94
MOPTI	34.62	35.16	-0.54
NIONO	35.27	35.16	0.11
KOLOKANI	43.03	49.14	-6.11
DOUENTZA	44.60	35.16	9.44
BLA	46.30	49.14	-2.84
YANFOLILA	52.18	55.99	-3.81
KOLONDIEBA	56.57	55.99	0.58
NIORO	58.43	49.14	9.29
BANDIAGARA	58.93	49.14	9.79
SIKASSO	59.84	55.99	3.85
BOUGOUNI	59.98	55.99	3.99
KITA	70.10	63.23	6.87
BAFOULABE	71.28	63.23	8.05
KATI	74.90	75.72	-0.82
KENIEBA	80.81	41.73	39.08

Limitations

- Insignificance of the variables included in the model:
  - Small sample size
  - Malaria prevalence ⇒ Aggregation of survey points
- No test spatial dependence

Further research

- Survey points data instead of regional mean malaria prevalence
- More than one country
- Improve the model
- Test/Correct for spatial dependence

Thank you

Questions?

I would like to acknowledge Dr.Kathleen P. Bell, Dr.Timothy Dalton, and Louis Morin for the time they spent helping me